Test Procedure for

ACCELERATED POLISH TEST FOR COARSE AGGREGATE

TxDOT Designation: Tex-438-A

Effective Date: August 1999

1. SCOPE

1.1 Use this method to estimate the polish and relative wear of coarse aggregate.

1.2 The values given in parentheses (if provided) are not standard and may not be exact mathematical conversions. Use each system of units separately. Combining values from the two systems may result in nonconformance with the standard.

2. DEFINITIONS

2.1 Blend—definite percentage mixture of two materials of different physical characteristics from different locations.

2.2 Initial Friction Value—the average of initial British Pendulum Tester (BPT) readings on test specimens before they are polished.

2.3 Polish Value—the average of a set of readings on the test specimen of aggregate after 9 hr. of polishing in the accelerated polishing machine; the ability of an aggregate to withstand the polishing effects of traffic wear.

3. APPARATUS

3.1 Wessex Accelerated Polishing Machine, based on a 1958 design by the Transport and Road Research Laboratory of Great Britain, conforming to the specifications outlined in Section 20, mounted on a firm, rigid, and level base.

3.2 British Pendulum Tester (BPT), conforming to the specifications outlined in Section 21.

3.3 Rubber sliders, new, conditioned, for the BPT.

3.4 Height measuring dial gauge, accurate to 0.025 mm (0.001 in.)

3.5 O-rings, rubber, 355.6 mm (14 in.) diameter with a thickness of 3.2 mm (0.125 in.)

3.6 Drying oven, capable of maintaining a temperature of 110 ± 5°C (230 ± 9°F).
3.7 Metal molds, to form test coupons.

Note 1—Coupons must have an exposed aggregate surface area 89 mm (3.5 in.) long, 44.5 mm (1.75 in.) wide, and 16 mm (0.675 in.) deep, with two outside mounting edges, measuring 6.4 mm (0.25 in.) deep and 3.2 mm (0.125 in.) wide, running the full length of the coupon.

4. MATERIALS

4.1 Grade 20-30 Ottawa sand (optional), meeting ASTM C 190.

4.2 Polyester resin and catalyst, with pot life of 10 min. and curing time of 3–6 hr.

4.3 Mold release agent (optional), for use with the polyester bonding agent.

4.4 Miscellaneous supplies, including disposable cups, spatula, or stirring rods.

4.5 Epoxy, two-component, of Type 8 hardener and Type 5 Resin

4.6 Silicon carbide grit (150 size), meeting American National Standard Institute (ANSI) gradation for No. 150.

Note 2—To re-use grit, dry to a constant temperature in a 110 ± 5°C (230 ± 9°F) oven, then screen over a 107 μm (No. 140) sieve. Reuse only the portion passing the sieve; discard the portion retained.

5. INSPECTING AND REPLACING SLIDER

5.1 To determine if the rubber slider needs replacement, visually inspect for cuts, burrs, detachment from the aluminum backing plate, wear on the striking surface, or other irregularities.

5.2 If wear on the striking edge exceeds 3 mm (1/8 in.) in the plane of the slider or 2 mm (1/12 in.) vertical to it, or if any other irregularities exist, replace it.

5.3 If a burr exists, sand gently with 2/0 emery polishing paper.

5.4 During cutting of rubber for new sliders, ensure to meet slider dimensions and cut at right angles.

5.5 The rubber compound must meet the requirements of ASTM E 501, with a Type A Shore durometer of 71 ± 3.

6. CONDITIONING NEW SLIDERS

6.1 Attach each rubber slider to an aluminum backing plate using the two-component epoxy.

6.2 Make ten swings on No. 100 grade silicon carbide cloth or equivalent under dry conditions with each slider.
6.3 Gently sand with 2/0 emery paper to remove any burrs produced during the initial ten swings.

6.4 Obtain a standard coupon from the Materials & Pavements Section of the Construction Division (CST/M&P) that has an assigned friction value.

**Note 3**—A standard coupon is a blank coupon made of polyester resin with the full width of the center 12.5 mm (0.5 in.) of the coupon length coated with Grade 20–30 Ottawa sand.

6.5 Drop the new sliders on the standard coupons following Part I, Sections 8.9–8.12. Record the polish values. Calculate the PV average and record the new slider average as NSA.

6.6 Use a previously conditioned backup slider to obtain a second set of polish values. Record the values. Calculate the PV average and record the backup slider average as BSA.

6.7 Compare the NSA to the BSA:

6.7.1 If the NSA is within ± two points of the BSA, conditioning is complete and the new slider is ready for use.

6.7.2 If the NSA is three or more points lower than the BSA, discard the slider.

6.7.3 If the NSA is three or more points greater than the BSA, go to Section 6.8.

6.8 If the NSA is three or more points greater than the BSA, make one swing on the carbide cloth with the slider, then drop the slider on the standard coupons and obtain a new NSA. Repeat Section 6.7.

**PART I—SINGLE-COMPONENT AGGREGATE**

7. **SCOPE**

7.1 This part describes the procedures necessary to estimate the polish and relative wear of single-component coarse aggregate.

8. **PREPARING TEST SPECIMENS**

8.1 Secure at least 14 kg (30 lb.) of the representative sample in accordance with Tex-400-A.

8.2 Separate out the portion of the aggregate sample passing the 9.5 mm (3/8 in.) sieve and retained on the 6.3 mm (1/4 in.) sieve.

8.3 Thoroughly wash the aggregate retained on the 6.3 mm (1/4 in.) sieve and dry to a constant mass at 110 ± 5°C (230 ± 9°F).

8.4 Coat the molds with the mold release agent (optional).
Thoroughly mix the sample obtained in Section 8.3 to ensure uniformity. Fill a 180-mL (6-fl. oz.) volumetric measure with a minimum diameter opening of 76 mm (3 in.) by running the measure through the material and striking off the excess material.

Split the sample obtained in Section 8.5 into eight equal portions using a sample splitter or quartering cloth.

Place seven portions of the split sample into the molds (one portion per mold) leaving a single layer of aggregate.

It may be necessary to remove material from the mold to achieve the single layer.

The eighth sample will be for extra material, if needed.

If there is not enough material to fill a mold to a single layer, hand pick the aggregate from the eighth sample to fill the mold.

Keep the removal of the flat, elongated, or irregular shaped rock to a minimum, as the intention is to simulate the texture of the road surface as much as possible. The resulting single layer should be representative of the evaluated material. The ratio of different morphology should be similar to that determined when doing a particle count, when requested.

For gravels, there is no need to place down crushed faces, but perform a crushed face count in accordance with Tex-460-A.

Fill the spaces between the aggregate particles with the Ottawa sand, to a depth between 1/4 and 1/2 the particle height (optional).

Follow the manufacturer's instructions to prepare the polyester resin and catalyst for the bonding agent.

Mix the resin to a consistency at which it can be spread onto and between the particles, but not so thin that it flows into the Ottawa sand (if sand is used) or onto the surface to be polished.

If necessary, add glycerin to the polyester resin to attain adequate consistency.

Fill prepared mold to capacity with the bonding agent.

Strike off and level the bonding agent with the curved sides of the mold.

Cure the bonding agent with the aggregate in the mold for 3–6 hr. until the agent is hardened.

Remove the specimen from the mold and brush any excess sand from the specimen surface (if applicable).

Smooth the bottom side of the test specimens with a grinding wheel or belt sander if warping prevents proper placement of the specimen on the polishing wheel.

Wear a respirator to prevent inhalation of the dust.
9. PROCEDURE

9.1 Using a waterproof marker, write the sample laboratory number and test date on the bottom of each test specimen. Label the coupons A–G on the bottom of each test specimen and mark the laboratory number on one side of each coupon.

9.2 Determine the initial friction value of specimens, if needed for reference purpose.

9.3 Clamp two sets (14 coupons) around the periphery of the polishing wheel. Face the side of the specimens with the lab number away from the machine. Place a rubber O-ring on both edges of the test specimens to hold them against the polishing wheel. Bolt the wheel flanges in place. Firmly press down on the O-rings and the edges of the specimens to secure them in place.

9.4 Mount the polishing wheel onto the Wessex Accelerated Polishing Machine. After starting the machine, the tire should ride freely without bumping or slipping. Maintain the temperature of the specimen, water, and apparatus at 24 ± 3°C (75 ± 5°F).

9.5 Feed silicon carbide grit (size 150) continuously to the polishing wheel near the tire contact point at a rate of approximately 6 ± 2 g per minute with water fed at 50–75 mL (1.7–2.5 fl. oz.) per minute. The polishing period should total 9 hr.

Note 6—Downtime does not affect the test results.

9.6 Remove the coupons from the polishing wheel and wash thoroughly to remove grit.

9.7 Submerge specimens in water for at least 1 hr. prior to BPT testing.

9.8 Prepare the BPT:

9.8.1 Visually inspect the rubber slider to ensure it does not need replacement.

9.8.2 Level the instrument by turning the leveling screws until the bubble is centered in the spirit level.

9.8.3 Ensure the pendulum is in release position with the drag pointer resting against the adjustment screw on the pendulum arm.

9.8.4 Release the pendulum and note the pointer reading. If the reading is not zero, loosen the locking ring, rotate the friction ring on the bearing spindle slightly, and relock. Repeat the test until the pointer reads zero.

9.9 Place a coupon in the bracket attached to the tester with the laboratory number facing the back of the pendulum.

9.10 Check and adjust the length of the slider contact path by releasing and slowly lowering the pendulum until it just touches the surface of the right edge of the test specimen.

9.10.1 Visually align the slider edge with the engraved marks on the bracket.
9.10.2 Using the lifting handle, raise the slider and move the pendulum to the left.

9.10.3 Slowly lower the pendulum until the slider edge again just comes to rest on the surface of the test specimen.

9.10.4 Visually align the slider edge with the engraved marks on the bracket.

9.10.5 If the length of the contact path is not between 75 mm (2-15/16 in.) and 78 mm (3-1/16 in.), adjust by raising or lowering the instrument with the vertical height control knobs.

9.10.6 Repeat this procedure each time a new specimen is tested.

9.11 Using a squirt bottle, apply sufficient tap water to cover the test area thoroughly. Immediately execute five swings, rewetting the test area after each swing.

**Note 7**—Always catch the pendulum during the early portion of its return swing. While returning the pendulum to its starting position, raise the slider with its lifting handle to prevent contact between the slider and the test surface. Prior to each swing, return the pointer until it rests against the adjustment screw.

9.12 Record the second through fifth readings. The test specimen polish value will be the average of these four values

**Note 8**—Maintaining the orientation of the test specimens as described in Sections 9.3, 9.4, and 9.9 is extremely important. This orientation allows testing of the specimens in the same direction as polishing on the wheel. If tested in the direction opposite of polishing, test results may be inaccurate.

**Note 9**—Although performing testing only on material passing the 9.5 mm (3/8 in.) sieve and retained on the 6.3 mm (1/4 in.) sieve, the polish value obtained is representative of all other sizes of material obtained from the same production.

10. REPORT

10.1 The final reported polish value is the average of the polish values obtained on the seven test specimens. Report to the nearest whole number.

PART II—BLENDDED AGGREGATES

11. SCOPE

11.1 This part describes the steps necessary to estimate the polish value and relative wear of blended aggregates.
12. METHOD A—DETERMINING POLISH VALUE FOR RANDOM BLENDS

12.1 Preparing Test Specimens:

12.1.1 Repeat Part I, Sections 8.1–8.4 for each aggregate type separately.

12.1.2 Select aggregate particles for placement in the mold on a percentage basis (i.e., one to nine particle ratio for a 10% blend, or one to four particle ratio for a 20% blend, etc.), and then randomly place in the bottom of the mold.

12.1.2.1 Make seven coupons for each blend to be tested.

12.1.2.2 For aggregate percentages to be properly representative, make sure that the two aggregates to be blended are similar in size.

12.1.3 Particles selected should be representative of the evaluated material. (Generally, flat, elongated, and odd-shaped particles will result in erratic or biased polish values.) Place the aggregate particles individually by hand in a single layer in the mold, as close together as possible. Place the flat surfaces down to produce a coupon with a smooth, even surface. Prepare seven coupons per sample to make a complete set.


12.2 Procedure:

12.2.1 Follow the procedure outlined in Part I, Section 9.

12.3 Report:

- initial friction value of the prepared test specimens (optional) for reference or rate of wear purposes,
- average of the polish values attained on the seven test specimens reported to the nearest whole number,
- company and pit names, producer codes, and percentages of the aggregate in the blend.

13. METHOD B—THEORETICAL DETERMINATION OF POLISH VALUE AND BLEND PERCENTAGE

13.1 Calculations:

13.1.1 Calculate the percentage, by volume, of non-polishing aggregate to use in a blend to meet a specified polish value:

\[
\text{Percent } H = 100 \cdot \left( \frac{PV_s - PVL}{PV_h - PVL} \right)
\]
Where:

\[ PV_s = \text{polish value required by specification} \]

\[ PV_h = \text{RSPV of a rated source or polish value of a non-rated source for non-polishing aggregate} \]

\[ PVL = \text{RSPV of a rated source or polish value of a non-rated source for the polishing aggregate to be improved} \]

\[ \text{Percent } H = \text{min. percent by volume retained on 2.00 mm (No. 10 sieve).} \]

**Note 10**—The Department’s Bituminous Rated Source Quality Catalog and Concrete Rated Source Quality Catalog include RSPV values for rated sources.

**Note 11**—That portion of the non-polishing aggregate retained on the 2.00 mm (No. 10) sieve should comprise at least the minimum percent by volume of the total aggregate required by the designated specification item. In addition, the blended aggregates should contain non-polishing aggregates of at least the minimum percent by volume of the critical size shown in the designated specification item.

### PART III—BLENDED AGGREGATES

#### 14. SCOPE

14.1 This part describes the steps necessary to determine an estimate of the resistance to wear of aggregates blended to improve the polish value.

#### 15. DEFINITIONS

15.1 *Differential Wear*—the measured difference of the amount of abrasion loss to the surface of randomly selected aggregate particles from each type of aggregate in the blend.

#### 16. PREPARING SPECIMENS

16.1 Repeat Part I, Sections 8.1–8.4 for each aggregate source separately.

16.2 Select aggregate particles for placement in the mold on a percentage basis (i.e., one to nine particle ratio for a 10% blend, or one to four particle ratio for a 20% blend, etc.), and then randomly place in the bottom of the mold.

16.2.1 Make four coupons for each blend to be tested.

16.2.2 For aggregate percentages to be properly representative, make sure that the two aggregates to be blended are similar in size.

16.3 Particles selected should be representative of the evaluated material. (Generally, flat, elongated, and odd-shaped particles will result in erratic or biased polish values.) Place the aggregate particles individually by hand in a single layer in the mold, as close together as possible. Place the flat surfaces down to produce a coupon with a smooth even surface. Prepare seven coupons per sample to make a complete set.

17. **PROCEDURE**

17.1 Mark a minimum of four particles of each type aggregate on each coupon with fast-drying contrasting color paint. Spread the marked particles randomly among all of the test specimens. Place the paint mark on the side where it will not abrade away.

17.2 Mount the test coupons on the height-measuring device.

17.3 Zero the height-measuring gauge on a cleaned and marked spot on the height-measuring device. Measure and record the surface elevation of each marked particle of aggregate. Place the head on the aggregate particles in such a way that the majority of the surface is covered. Do not let the head touch any other particle other than the one being measured. If the head does not cover the whole particle, place the head as nearly in the center of the particle as possible.

17.4 Subject the coupons to the polishing test described in Part I, Section 9 for 9 hr.

17.5 Remove the polished coupons and determine final height measurements as described in Section 17.3.

18. **CALCULATIONS**

18.1 Calculate the particle wear:

\[
\text{Particle Wear} = \text{initial height measurement} - \text{final height measurement}
\]

18.2 Record to the nearest 0.025 mm (0.001 in.)

19. **REPORT**

19.1 Report pass or fail.

**Note 12**—If the average particle wear of the non-polishing (highest PV) aggregate is equal to or less than the average particle wear of the polishing aggregate, the differential wear is acceptable.

**Note 13**—If blending more than two coarse aggregates to achieve a combined polish value, the average particle wear of the non-polishing aggregate should be the average of all measured non-polishing aggregate.

20. **SPECIFICATIONS FOR WESSEX ACCELERATED POLISHING MACHINE**

20.1 *Polishing wheel*, 406 mm (16 in.) in diameter, with a flat-surface periphery to hold 14 specimens 44 × 89 mm (1-3/4 × 3-1/2 in.)
20.2 Means capable of rotating the polishing wheel about its own axis, at 320 ± 5 rpm.

20.3 Means capable of bringing the surface of a rubber-tired wheel to bear on the aggregate specimens, with 391 ± 2 N (88 ± 1 lb.) of force. The tire must be free to rotate about its own axis, with a plane of rotation that coincides with that of the polishing wheel.

20.4 Cross-hatching pattern tread tire, equivalent to a Goodyear Industrial All Weather Hand Truck Tire, Size 203 × 102 ID × 71 mm (8 × 4 ID × 2.80 in.), 4 NHS-4 Ply, Goodyear Product Code 202-008-002, with a suitable inner-tube such as Goodyear G.250-4, Product Code 199-010-700. Inflate the tire to 241 ± 14 kPa (35 ± 2 psi). Minor modifications to the rim may be required for the tire to fit properly.

20.5 Grit feeder, capable of feeding the 150-grit silicon carbide abrasive at a rate of 6 ± 2 g per min. Feed the grit continuously and uniformly across the width of the specimens ahead of the point of contact with the rubber-tired wheel.

20.6 Water feeder, capable of discharging water at a rate of 50–75 mL (1.7–2.5 fl. oz.) per min. Spread the water continuously and uniformly over the surface of the aggregate specimens ahead of the point of contact with the rubber-tired wheel.

21. SPECIFICATIONS FOR THE BRITISH PENDULUM TESTER

21.1 Pendulum, slider, and slider mount, weighing 1500 ± 30 g.

21.1.1 Distance from the center of gravity of the pendulum to the center of the oscillation must be 411 ± 5 mm (16.2 ± 0.2 in.)

21.2 Tester, with a vertical adjustment capability to provide a slider contact path of 125 ± 2 mm (4-15/16 ± 1/16 in.) for tests on flat surfaces (i.e., actual roadway), and 75 to 78 mm (3 to 3-1/16 in.) for polish wheel specimens.

21.3 Spring and lever unit, to deliver an average normal slider load between the slider and test surface of 24.5 ± 1 N (5.5 ± 0.2 lb.) at a slider displacement of 6.30 mm (1/4 in.)

21.4 Slider assembly, consisting of an aluminum backing plate on which a 6 × 25 × 75 mm (1/4 × 1 × 3 in.) rubber strip is bonded for testing flat surfaces. For curved polish wheel specimens, a 6 × 25 × 32 mm (1/4 × 1 × 1-1/4 in.) rubber strip is used.